PATENT ABSTRACTS OF JAPAN

(11)Publication number : 07-052706
(43)Date of publication of application : 28.02.1995

(51)Int.Cl. B60Q 1/14
F21M 3/05
F21M 3/18
H04N 7/18

(21)Application number : 05-206070
(22)Date of filing : 20.08.1993

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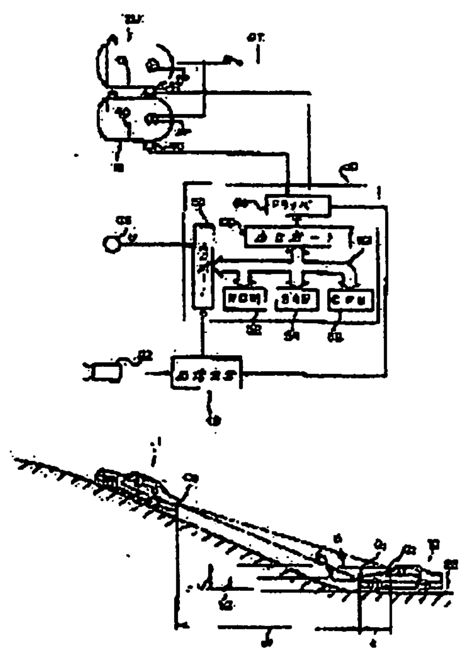
(54) LIGHT DISTRIBUTION CONTROL DEVICE FOR HEAD LAMP



(57)Abstract:
PURPOSE: To irradiate optimum positions without putting the other vehicle in the glare of light by controlling the direction and range of irradiation so as not to irradiate the mirror of a preceding vehicle and the eye point of the driver of an opposed vehicle on the basis of the distance between head lamps and an image detecting means, the detected direction and the inter-vehicle distance.
CONSTITUTION: A control angle θ is obtained from a direction angle ϕ and inter-vehicle distance ΔV obtained by an processing device 48 from the positions Q1 of the head lamps 18, 20 of an own vehicle 10, the position Q2 of a camera 22 and the boundary position (cut line position) Q3 of the light and dark parts of light distribution for preventing glare to a preceding vehicle 11, and an optical axis is moved vertically according to the control angle θ. The moving quantity of actuators 46, 47 corresponding to this angle is computed. In this case, the moving quantity is made smaller than the maximum moving quantity to become the control angle θ. For instance, an irradiation range is to be below the predetermined positions of a rear view mirror and a fender mirror from the positions of tail lamps in the preceding vehicle, and below the eye point position of

an occupant from the positions of the head lamps 18, 20 in the opposed vehicle.

LEGAL STATUS

[Date of request for examination]	26.08.1997
[Date of sending the examiner's decision of rejection]	
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]	
[Date of final disposal for application]	
[Patent number]	2861744
[Date of registration]	11.12.1998
[Number of appeal against examiner's decision of rejection]	
[Date of requesting appeal against examiner's decision of rejection]	
[Date of extinction of right]	

* NOTICES *

CLAIMS

[Claim(s)]
[Claim 1] The luminous-intensity-distribution control unit of a head lamp characterized by providing the following A picture detection means for it to be arranged in a different position from the head lamp which can change either [at least] the direction of radiation or the irradiation range, and to detect the picture ahead of self-vehicles An operation means to find the distance between two cars of the other car and self-vehicles while asking for the detection direction of the other car on the basis of the aforementioned picture detection means based on the detected picture, It is based on the distance of the aforementioned head lamp and the aforementioned picture detection means, the aforementioned detection direction, and the distance between two cars. When the aforementioned other car is precedence vehicles, while making it light not irradiated by the mirror for a back check of precedence vehicles, when the aforementioned other car is opposite vehicles, in order to make it light not irradiated by the eye point of the driver of opposite vehicles, Control means which ask for the control direction on the basis of the aforementioned head lamp, and control either [at least] the direction of radiation of the aforementioned head lamp, or the irradiation range based on this control direction

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[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] this invention starts the luminous-intensity-distribution control unit of a head lamp, and relates to the luminous-intensity-distribution control unit of the head lamp which controls in detail the luminous intensity distribution of the head lamp which irradiates the front of vehicles.
[0002]
[Description of the Prior Art] The head lamp is arranged by vehicles in order to raise the visibility ahead of a driver at night etc. Although the large area is irradiated comparatively, a driver cannot irradiate a part required to view brightly during the run when this head lamp being fixed at the nose of cam of abbreviation of vehicles, and being set beforehand at which vehicles circle. For this reason, the front lighting system for vehicles which forms a shutter in the irradiation side of the front lighting system for vehicles and head lamp which change the irradiation optical axis and irradiation range of a head lamp according to a steering angle etc., and changes the irradiation range by opening and closing of a shutter is proposed (JP,55-22299,B, JP,2-27938,U, JP,1-293247,B).
[0003] By the way, ahead [self-vehicles], the other cars, such as precedence vehicles, usually exist. When the other car exists ahead [this / self-vehicles] and luminous intensity distribution are controlled only from the direction of self-vehicles, such as a steering angle, the driver of the other car may sense dazzling. In order to cancel this, the self-vehicles front is photoed and the front lighting system for vehicles which is extracted and is switched to a low beam from a high beam in quest of the distance between interval empty vehicles of the extracted tail lamp is proposed by carrying out the image processing of the tail lamp of the other car from a photography picture (JP,62-131837,A).
[0004]
[Problem(s) to be Solved by the Invention] However, vehicles run ways, such as a passage, are not restricted to continuation of a flat surface with a fixed road surface configuration, and may have the inclination of a slope, a mountains passage, etc. Therefore, the position of the other car on a photography picture becomes various. For example, it may be located in the same part on the photography picture which the other car which runs the vehicles front by the difference of elevation of a passage photoed with the camera. For this reason, the position of the other car is accidentally pinpointed from the picture ahead of vehicles, and it may be controlled by luminous intensity distribution which give dazzle to the other car.
[0005] this invention aims at offer of the luminous-intensity-distribution control unit of the head lamp which can irradiate the optimal position which does not give dazzle to the other car and a driver views in consideration of the above-mentioned fact.
[0006]
[Means for Solving the Problem] A picture detection means for this invention to be arranged in a different position from the head lamp which can change either [at least] the direction of radiation or the irradiation range in order to attain the above-mentioned purpose, and to detect the picture ahead of self-vehicles, An operation means to find the distance between two cars of the other car and self-vehicles

while asking for the detection direction of the other car on the basis of the aforementioned picture detection means based on the detected picture, It is based on the distance of the aforementioned head lamp and the aforementioned picture detection means, the aforementioned detection direction, and the distance between two cars. When the aforementioned other car is precedence vehicles, while making it light not irradiated by the mirror for a back check of precedence vehicles, when the aforementioned other car is opposite vehicles, in order to make it light not irradiated by the eye point of the driver of opposite vehicles, It asked for the control direction on the basis of the aforementioned head lamp, and has the control means which control either [at least] the direction of radiation of the aforementioned head lamp, or the irradiation range based on this control direction.

[0007]

[Function] The luminous-intensity-distribution control unit of the head lamp of this invention is equipped with the picture detection means arranged in a different position from the head lamp which can change either [at least] the direction of radiation or the irradiation range. A picture detection means detects the picture ahead of self-vehicles. There are image pck-up equipments, such as a TV camera and an infrared camera, in this picture detection means. Moreover, the direction of radiation of a head lamp can be defined by the optical axis of a head lamp, and the irradiation range can be defined with the configuration and position of a member which shade the angle of divergence of the light injected from a head lamp, and light. With an operation means, while asking for the detection direction of the other car on the basis of a picture detection means based on the detected picture, the distance between two cars of the other car and self-vehicles is found. There are precedence vehicles and opposite vehicles in this other car. When precedence vehicles and opposite vehicles run the front at the time of a self-vehicles run, a bird clapper has identically the position of the other car in the picture detected by the road grade ahead of self-vehicles etc. Thereby, when the positions of a picture detection means and a head lamp differ, and it asks for the direction which controls a head lamp from the detected picture, a bird clapper tends to differ from the direction of desired. It can ask for the direction of this request by pinpointing the position of the other car, and can ask for the position of the other car from the distance of a head lamp and a picture detection means, the detection direction, and the distance between two cars. Then, based on the distance of a head lamp and a picture detection means, the detection direction, and the distance between two cars, while making it light not irradiated by the mirror for a back check of precedence vehicles, it asks for the control direction on the basis of the head lamp for making it light not irradiated by the eye point of the driver of opposite vehicles, and either [at least] the direction of radiation of a head lamp or the irradiation range is controlled by control means based on the control direction for which it asked. Thus, since it controls so that the position or direction where the other car senses dazzle for the direction of radiation and the irradiation range of a head lamp are not included, even if the other car exists in the run way which has inclination etc., according to this inclination etc., the light by the optimal direction of radiation or the irradiation range is irradiated by run ways, such as a passage.

[0008]

[Example] Hereafter, with reference to a drawing, the example of this invention is explained in detail. this example photos the front of vehicles 10 with a camera, and when controlling the luminous intensity distribution of a head lamp based on this gradation picture, it applies this invention.

[0009] As shown in drawing 1 , the engine hood 12 is arranged at the upper surface section of front body 10A of vehicles 10, and the head lamps 18 and 20 of a right-and-left couple (cross direction both ends) are arranged in the upper part of the front bumper 16 fixed to the cross direction both ends of the front end section of front body 10A. Moreover, windshield glass 14 is formed near the back end section of the engine hood 12. It is the upper part of this windshield glass 14, and the room mirror 15 is formed in the vehicles 10 interior, and the camera 22 for photoing the vehicles front night near the visual position (the so-called eye point) of a this about 15 room mirror driver is arranged. This camera 22 is connected to the image processing system 48 (drawing 5). The camera for night vision with the image-intensifier pipe which carries out multiplication of the intensity of the dark visible image which received the X-ray, the corpuscular ray, etc., and is changed into a bright visible image may be used for this camera 22. In addition, the speedometer which is not illustrated is arranged in vehicles 10 and the vehicle speed sensor

66 (drawing 5) which detects the vehicle speed V of vehicles 10 is attached in the cable which this speedometer that is not illustrated does not illustrate.
[0010] As shown in drawing 2 , a head lamp 18 is a projector type head lamp, and has the lamp house 34. A convex lens 30 is fixed to one opening of this lamp house 34, and the bulb 32 is being fixed to opening of another side through the socket 36 so that the point emitting light may be located on the optical axis L of a convex lens 30 (medial axis of a convex lens 30).
[0011] The bulb side of the lamp house 34 interior is used as the reflector 38 of an ellipse reflector, and the reflected light of the bulb 38 by this reflector 38 is condensed between a convex lens 30 and a bulb 32. It is fixed so that the upper limit of the shade 40 (refer to drawing 3) may be located near [this] a condensing point. The configuration of this shade 40 is beforehand set to the ****** sake of a check-by-looking disposition top, such as a pedestrian of a driver, and an indicator, or an oncoming car, and the light of the bulb 32 in which reflective condensing was carried out by the reflector 38 is divided by passage light and the shaded light, and is injected by the shade 40 from a convex lens 30.
[0012] Moreover, bearing 42 is being fixed to up front part 34A of a lamp house 34. This bearing 42 is supported to revolve by the support 44 fixed at a level with the frame which vehicles 10 do not illustrate. Moreover, the nose of cam of the shape of a cylinder of needle 46A of an actuator 46 is attached in lower back part 34B of a lamp house 34. It is fixed to the frame which vehicles 10 do not illustrate, and this actuator 46 consists of worm gearing which uses motor 46D and needle 46A as a worm. That is, the back end of needle 46A is engraved so that it may function as a worm, and it is clenched by worm wheel 46B. Movement of this needle 46A is linearly enabled by the sliding mechanism which is not illustrated, the axis of rotation of worm wheel 46B is fixed to shaft 46C of motor 46D, and rotation of motor 46D is changed into the straight-line drive of needle 46A. Therefore, needle 46A expands and contracts perpendicularly (the direction of drawing 2 arrow A) by rotation of motor 46D according to the signal from a control unit 50. If needle 46A contracts, the RLC of the head lamp 18 will be carried out, an optical axis L turns into an optical axis LU, if needle 46A develops, the RRC of the head lamp 18 will be carried out, and an optical axis L will turn into an optical axis LD. Thus, according to expansion and contraction of needle 46A, a head lamp 18 rotates a support 44 as a shaft, and an optical axis L is deflected in the vertical direction (UP or the DN direction of drawing 1).
[0013] The head lamp 20 is equipped with the shade 41 and the actuator 47 (drawing 5). Since the composition of a head lamp 20 is the same as that of a head lamp 18, detailed explanation is omitted.
[0014] The cutline which is the boundary of light and darkness with the above-mentioned shade is located in a road, and by rotation of a head lamp, as shown in drawing 4 , a cutline is displaced to parallel from the position (position of the cutline of drawing 4) corresponding to the least significant of the upper part of the shade to the position (position of the fictitious outline of drawing 4) corresponding to the most significant. In addition, you may control the above-mentioned shade to achieve right-and-left independence and to move from the center of drawing.
[0015] As shown in drawing 5 , the control unit 50 is constituted including the buses 62 which connect a read-only memory (ROM) 52, RAM (RAM) 54, a central processing unit (CPU) 56, input port 58, an output port 60, and these, such as a data bus and a control bus. In addition, the control program mentioned later is memorized by this ROM52.
[0016] The vehicle speed sensor 66 and the image processing system 48 are connected to input port 58. The output port 60 is connected to the image processing system 48 while connecting with actuators 46 and 47 through a driver 64.
[0017] In addition, the road configuration corresponding to one lane formed with a configuration (white line), for example, the center line, a curbstone, etc. of an advance way is included in the above-mentioned road configuration.
[0018] Next, recognition processing of the other car in the image processing of this example and data processing of the distance between two cars are explained. In addition, each pixel on the image formed of a picture signal pinpoints a position with the coordinate (Xn and Yn) of the system of coordinates which become settled by the X-axis which was set up on the image, and which intersects perpendicularly respectively, and the Y-axis.

[0019] As shown in drawing 6 (1), the precedence vehicles 11 are located in the white line 124 of the lane both sides of the road 122 vehicles 10 run with the image 120 which is the picture photoed with the camera 22. In an image processing system 48, the image processing of this image 120 is carried out.
[0020] First, after performing white line candidate point sampling processing and straight-line approximation processing in order as follows and detecting the run lane of vehicles 10, it is the vehicles recognition field WP. It sets up.
[0021] In white line candidate point sampling processing, the candidate point presumed to be the white line of a lane is extracted. First, window field WS which has the predetermined width of face gamma presumed that a white line is included It sets up (refer to drawing 6 (3)), and is this window field WS. Change of an inner luminosity extracts a large point (the maximum point of the differential value of a vertical luminosity) as a white line candidate point (edge point). The case where it asked for continuation of this edge point was shown in the dotted line 132 of drawing 6 (3). In addition, since the accuracy in which the precedence vehicles 11 exist is low, the range between the upper limit line 128 beforehand defined as a processing-object field and the minimum line 130 is used for the field of the upper and lower sides of an image 120.
[0022] It asks for the straight lines 134 and 136 which met the line which carries out straight-line approximation of the edge point extracted by white line candidate point sampling processing using the Hough (Hough) conversion, and is presumed to be a white line in the next straight-line approximation processing. It is the vehicles recognition field WP about the field surrounded by these straight lines 136 and 138 and the minimum line 130. It sets up by carrying out (refer to drawing 6 (4)). In addition, vehicles recognition field WP with the inclination difference of the straight lines 136 and 138 for which it asked the account of a top when the above-mentioned road 122 was a curve way It becomes (refer to drawing 6 (2)).
[0023] Vehicles recognition field WP Inside WP of the vehicles recognition field set up by carrying out detection processing as follows after a setup was completed While judging the existence of the precedence vehicles 11 which can be set, distance-between-two-cars deltaV is calculated at the time of ** of the precedence vehicles 11.
[0024] First, vehicles recognition field WP Peak point EP of a position that detect an edge point like the above-mentioned white line candidate check appearance processing inside, and the integration value which integrated with the detected edge point in the longitudinal direction exceeds a predetermined value It detects (refer to drawing 6 (5)). In addition, peak point EP When there are more than one, the peak point EP (nearer point of distance) of being located below on a picture is chosen. This peak point EP The window field WR which includes the ends of a horizontal corresponding pixel respectively, and WL It sets up (refer to drawing 6 (6)). This window field WR and WL When a vertical continuing point (vertical lines 138R and 138L) is stabilized inside and detected inside, it judges with the precedence vehicles 11 existing.
[0025] Since it corresponds to breadth of a car, the interval of the longitudinal direction of these detected vertical lines 138R and 138L is this breadth of a car and the peak point EP. Distance-between-two-cars deltaV of the precedence vehicles 11 and the self-vehicles 10 is calculated from a position. The interval of the longitudinal direction of vertical lines 138R and 138L can be calculated from the difference of each typical X coordinate (for example, an average coordinate value and the coordinate value of many frequency) of vertical lines 138R and 138L.
[0026] Next, recognition processing of oncoming car both 11A from an image 120 is explained. First, after the above-mentioned precedence vehicles recognition processing, the amount alpha of amendments of an amendment sake is set up so that the approximation straight line 132 (oncoming car both sides) for which it asked may be included. Since the accuracy to which opposite vehicles are located in about 132 approximation straight line of oncoming car both sides is high, this amendment is for an amendment about this. The method of the right of the straight line 133 for which it asked in quest of the straight line 133 according to this set-up amount alpha of amendments (at the time of left-hand traffic) is set up as oncoming car both recognition field WPO (refer to drawing 7). In oncoming car both this recognition field WPO, like the above-mentioned precedence vehicles recognition processing, recognition

processing of the oncoming car both 11A is carried out, and it asks for distance-between-two-cars deltaV.

[0027] In addition, although a white line 124 is detected above and the road is pinpointed, the curbstone formed in the side edge section of a road 122 may detect, without using only a white line 124. In this case, each can detect a white line and a curbstone by changing the disregard level of a gradation picture.

[0028] Next, the processing which asks for the direction of the other car by the road grade etc. with an image processing system 48 from the image of the photoed picture is explained. The image 120 used as the criteria which carry out abbreviation coincidence with the picture which the driver when photoing the flat road 122 vehicles 10 run with a camera 22 views was shown in drawing 8 . By this road 122, the center line 123 is made into the boundary of each lane, and let the white lines 124 be boundaries a road 122 and other than it.

[0029] The reference point D (XD and YD) of the position corresponding to a look (direction parallel to a flat road) when a driver views the front to the run direction of vehicles 10 and parallel is beforehand set to the image 120. Let the lines which make this reference point D (XD and YD) the reference point of the image 120 photoed by the camera 22, and pass through a reference point D respectively, and intersect perpendicularly respectively be a horizontal line Hor and a vertical line Ver. This horizontal line Hor is in agreement with the horizon of the image 120 photoed when vehicles 10 ran the flat ground.

[0030] As shown in drawing 9 , the image 121 photoed with the camera 22 in case the passage 122 ahead of the vehicles 10 which are running the flat ground is the downward slope which has the inclination of an angle theta from the flat ground becomes the compression picture which went in the direction of downhill, and the horizon of an image 121 moves it to a lower part from the position of the horizon when photoing the flat passage 122. Therefore, horizontal line Hm which passes the pixel of the center line 123 of this image 121, and the topmost part grade of tracing of the pixel on the image of a white line 124 Deflection deltaH with the horizontal line Hor which passes through a reference point corresponds to the above-mentioned inclination. Therefore, horizontal line Hm corresponding to the horizon of the image photoed as mentioned above If it asks for deflection deltaH and an optical axis L is made to go up and down according to the size of this deflection deltaH after asking for a position, a driver can irradiate sufficient field to view by the head lamp.

[0031] It can ask for the direction of the other car on the basis of a camera (the vectorial angle phi from a horizontal line) using such an inclination deriving method. That is, since the position of the perpendicular direction on the image of the tail lamp which carried out [above-mentioned] detection corresponds in the direction of the other car, it is the above-mentioned horizontal line Hm. If a position is replaced with the position of a tail lamp (it is a head lamp at the time of precedence vehicles and opposite vehicles) and it asks for deflection deltaH, it can ask for the direction of the other car.

[0032] Here, with inclination of the passage ahead of vehicles etc., even if the distance between two cars differs and the time of the position of the other car on an image becoming the same and the distance between two cars are the same, the position of the other car on an image may change. As shown in drawing 10 , even if distance-between-two-cars deltaV from the self-vehicles 10 to the precedence vehicles 11 differs, the position on an image has a bird clapper as it is the same. In this case, both the angles for which it asked as a phase control angle for carrying out luminous-intensity-distribution control from an image are angles phi. On the other hand, since the height to the passage of a head lamp and a camera differs, the phase control angle theta which deflects the optical axis of a head lamp becomes a different angle. That is, a phase control angle is set to angle thetaa in precedence vehicles 11a near the self-vehicles 10, and a phase control angle is set to angle thetab in precedence vehicles 11b far from the self-vehicles 10.

[0033] Then, as this example showed to drawing 11 , it is a point Q2 about the arrangement position of a point Q1 and a camera in the head-lamp position of the self-vehicles 10. It is a point Q3 about the position (they are the boundary position of the light-and-darkness section of anti-dazzle **** luminous intensity distribution, and a cutline position to the precedence vehicles 11) which was carried out and near the tail lamp of the precedence vehicles 11 defined beforehand. If it carries out, it can ask for the

phase control angle theta on the basis of a head lamp
[0034]
[Equation 1]

$$\theta = \tan^{-1} \frac{h1 - h2 + (\Delta V + d) \cdot \tan\phi}{\Delta V} \quad --- (1)$$

[0035] however, an h1:passage to point Q1 up to -- height h2: -- a passage to point Q2 up to -- height d : Point Q1 Point Q2 Horizontal distance phi : the vectorial angle of the other car on the basis of a camera -- therefore Ask for the vectorial angle phi with the distance between two cars and a camera using the photoed image, and if it asks for the phase control angle theta by the head lamp from the found distance between two cars and a vectorial angle phi and an optical axis L is made to go up and down according to the size of this phase control angle theta a driver -- sufficient field to view -- and the other car -- anti-dazzle **** -- luminous intensity distribution [like] can be irradiated by the head lamp
[0036] Hereafter, an operation of this example is explained. First, if a driver turns on the light switch which vehicles do not illustrate and head lamps 18 and 20 are made to turn on, the luminous-intensity-distribution control main routine shown in drawing 12 for every predetermined time will be performed, and it will progress to Step 202. At Step 202, while outputting the image reading signal which is an indication signal which starts an image processing to an image processing system 48, data called for in the image processing system 48, such as existence of the other car, are read. In an image processing system 48, if an image reading signal is inputted, the image processing of the image of a photography picture will be carried out, and the existence, the distance between two cars, and the vectorial angle phi of the other car will be called for so that it may mention later.
[0037] At the following step 204, it judges whether the other car has been recognized in an image processing system 48, and when the other car is on an image, it progresses to Step (affirmative judgment) 206. At Step 206, from the distance between two cars found with the image processing system 48, and a vectorial angle phi, it asks for the phase control angle theta on the basis of a head lamp based on the above-mentioned formula (1), and the movement magnitude of the actuators 46 and 47 corresponding to the angle which the optical axis L which is an actual controlled variable accomplishes is calculated. In this case, if the maximum movement magnitude of the actuators 46 and 47 used as a phase control angle theta is calculated and it is made movement magnitude smaller than this maximum movement magnitude, even if it is which movement magnitude, it will become anti-dazzle ****** movement magnitude to the other car. For example, what is necessary is just a lower part from the position of crew's eye point beforehand defined from the position of a head lamp by opposite vehicles that what is necessary is just a lower part from the position of the door mirror beforehand defined from the position of a tail lamp by precedence vehicles, or a side-view mirror.
[0038] At the following step 208, actuators 46 and 47 are moved according to the calculated movement magnitude, the optical axis of head lamps 18 and 20 is deflected, and this routine is ended.
[0039] On the other hand, when the other car did not exist and negative judgment is carried out in Step 204, it progresses to Step 210. When the other car does not exist, since the vehicles front is a passage, a driver makes the angle beforehand set that sufficient field to view is irradiated a phase control angle theta supposing the case where it runs a flat passage, and it calculates a controlled variable. Moreover, when inclination is in a passage, a controlled variable is calculated on the basis of a flat passage by making the vectorial angle phi according to the inclination of a passage into a phase control angle theta.
[0040] Next, the image processing in the image processing system 48 of this example is explained with reference to drawing 13 . An image processing system 48 will read the image 120 (refer to drawing 5 (1)) of the picture ahead of the vehicles 10 photoed with the camera 22, if an image reading signal is inputted from a control unit 50 (Step 302). Recognition processing of the precedence vehicles explained above using this read image 120 and opposite vehicles is performed (Step 304). At the following step 306, it judges whether the other car exists on an image, and when the other car is on an image, it

progresses to Step (affirmative judgment) 308. At Step 308, it asks for distance-between-two-cars deltaV by the image processing which asks for the horizontal interval of the extracted edge point of having explained above. On the other hand, since it is not necessary to ask for negative judgment) and distance-between-two-cars deltaV at the (step 306 when the other car does not exist, it progresses to Step 310.

[0041] At Step 310, it asks for the vectorial angle phi by the inclination of a road by asking for the variation rate of the horizontal line changed on an image as explained above. At this step 310, when the other car exists, it asks for a vectorial angle phi by making into level line position the position (for example, the position beforehand defined from the position of a tail lamp by precedence vehicles, the position beforehand defined from the position of a head lamp by opposite vehicles) of the anti-dazzle **** sake beforehand defined to the other car.

[0042] The data which express with the following step 312 the existence of the other car for which it asked above, distance-between-two-cars deltaV, and a vectorial angle phi are outputted, and an image processing is ended.

[0043] thus -- since it asks for the phase control angle theta by the position of the head lamp actually controlled by this example from the vectorial angle phi with the distance between two cars and the camera for which it asked using the photoed image and is made to carry out luminous-intensity-distribution control according to the size of this phase control angle theta -- a driver -- sufficient luminous intensity distribution to view -- and the other car -- anti-dazzle **** -- luminous intensity distribution [like] can be irradiated by the head lamp

[0044] In addition, although it was made to carry out luminous-intensity-distribution control in the above-mentioned example, application to the equipment which is made to move shading meanses, such as the shade arranged in the light source's injection side, and carries out luminous-intensity-distribution control is also possible for this invention, without being limited to this.

[0045] Moreover, although the above-mentioned example explained the case where the distance between picture empty vehicles photoed with the camera was found, you may make it measure the distance of the other car and self-vehicles for a distance-between-two-cars measuring device separately in preparation for vehicles.

[0046]

[Effect of the Invention] according to [as explained above] this invention -- the distance of a head lamp and a picture detection means, the detection direction, and the distance between two cars -- being based -- the direction of radiation of a head lamp, and the irradiation range -- even if few, in order to change one side, even if it is the case where the controlled variable of the angle of the optical axis at the time of luminous intensity distribution, the position of a shading means, etc. changes with the inclination of a road etc., it is effective in the ability to be able to irradiate the optimal

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[Translation done.]

* NOTICES *

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the perspective diagram seen from the vehicles slanting front which shows the vehicles anterior part of this example.
[Drawing 2] It is the outline block diagram showing the head lamp which can apply this invention.
[Drawing 3] It is the diagram (view view of drawing 2) showing the composition of the shade.
[Drawing 4] It is an image view for explaining the cutline displaced by expansion and contraction of an actuator.
[Drawing 5] It is the block diagram showing the outline composition of a control unit.
[Drawing 6] It is an image view for explaining process in which precedence vehicles are recognized based on the picture which a camera outputs.
[Drawing 7] It is the image view showing oncoming car both the recognition field.
[Drawing 8] It is the image view of the picture signal which a camera outputs.
[Drawing 9] It is the image view of the photography picture of the passage which has inclination.
[Drawing 10] It is the image view showing the state where self-vehicles and precedence vehicles run the passage which has inclination.
[Drawing 11] It is an image view for explaining the phase control angle in the passage which has inclination.
[Drawing 12] It is the flow chart which shows the luminous-intensity-distribution control main routine of this example.
[Drawing 13] It is the flow chart which shows the manipulation routine of the image processing system of this example.
[Description of Notations]
18 Head Lamp
22 Camera
48 Image Processing System

[Translation done.]

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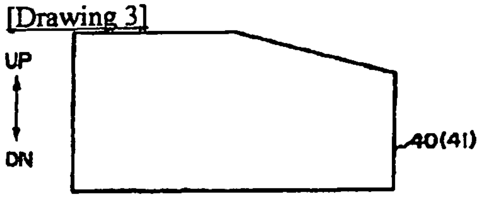
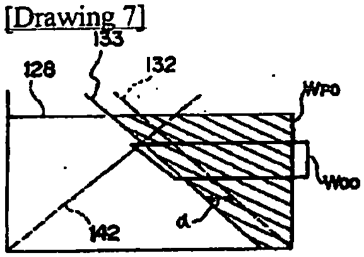
DRAWINGS

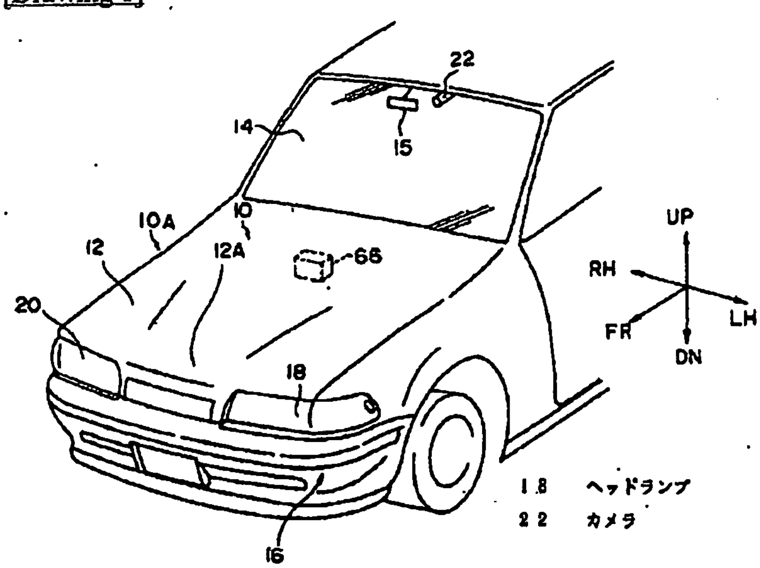
[Drawing 3]



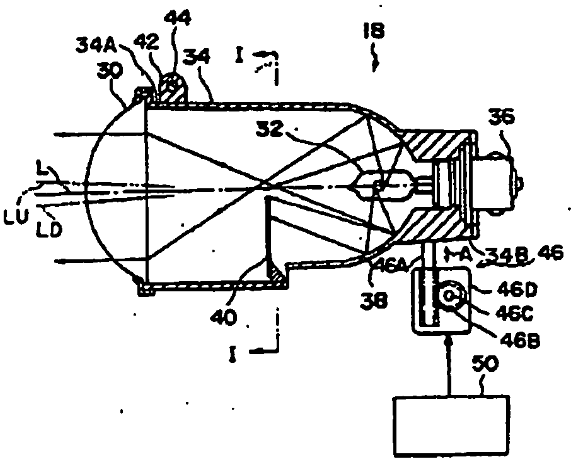
[Drawing 7]



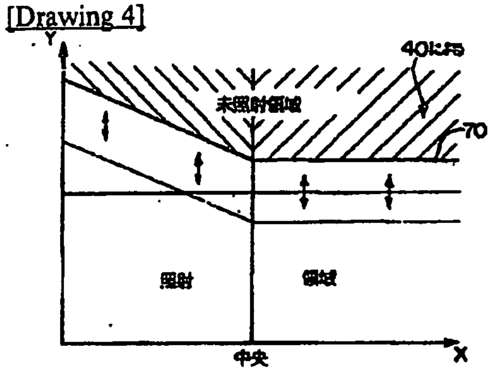
[Drawing 1]



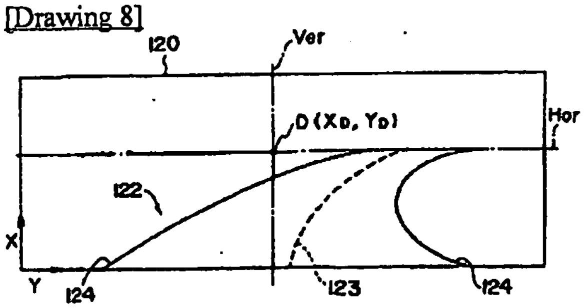
[Drawing 2]



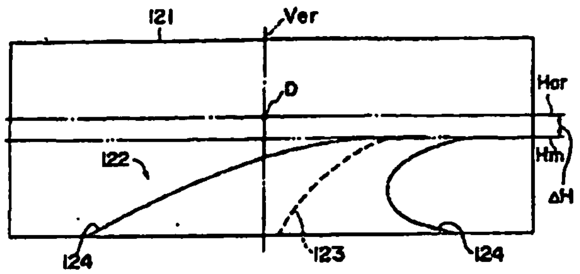
[Drawing 4]



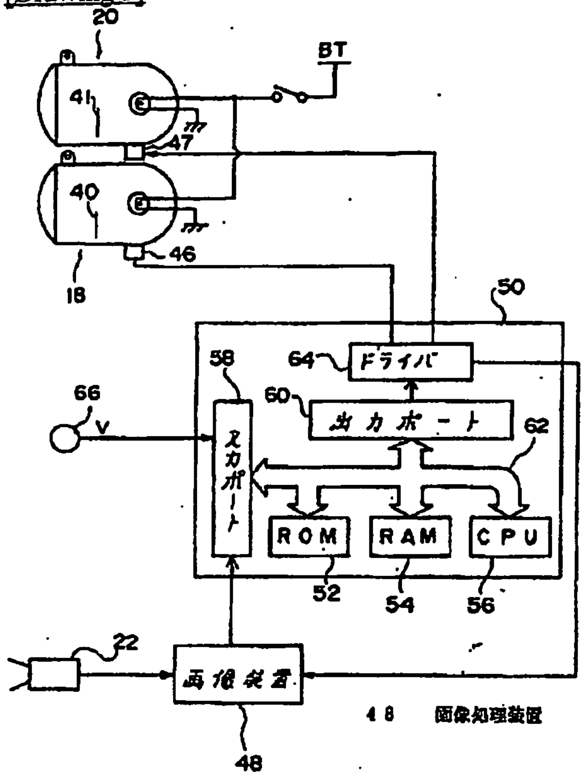
[Drawing 8]



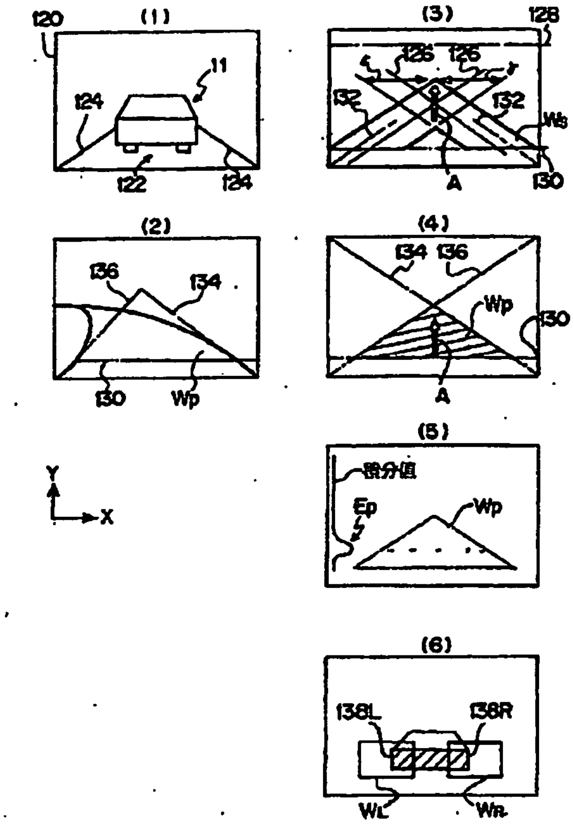
[Drawing 9]



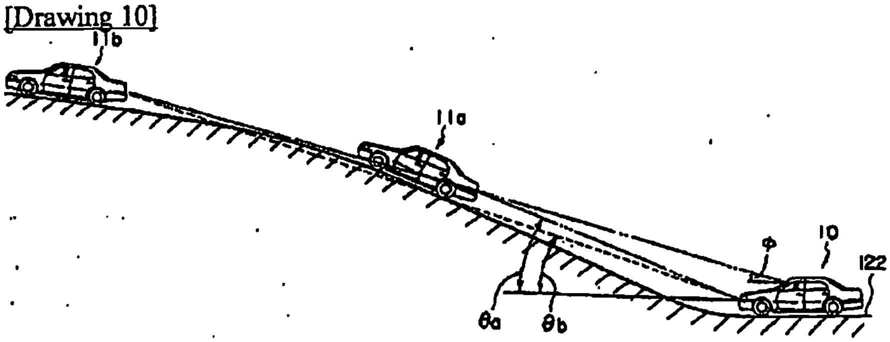
[Drawing 5]



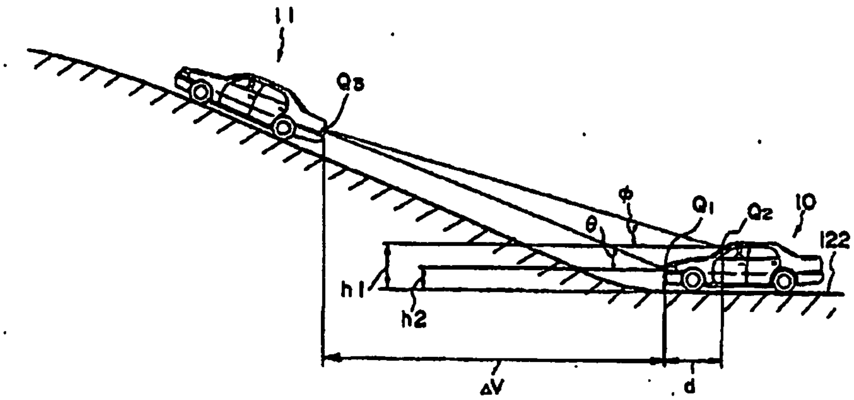
[Drawing 6]



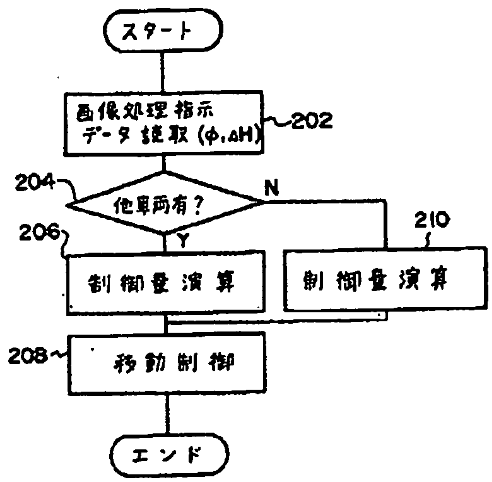
[Drawing 10]



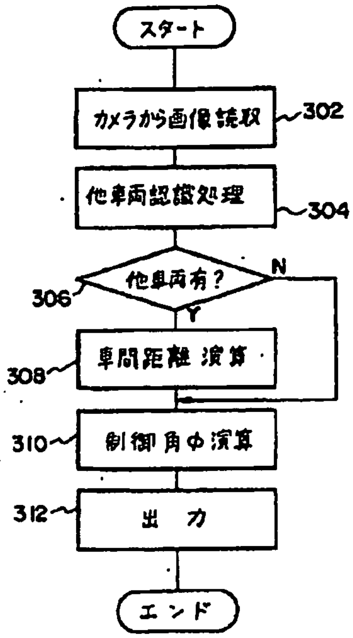
[Drawing 11]



[Drawing 12]



[Drawing 13]



[Translation done.]

(19) Japan Patent Office (JP)
(12) Publication of Patent Application
(11) Publication Number of Patent Application: 7-52706
(43) Date of Publication of Application: February 28, 1995

(51) Int.Cl.[6]	Identification Number	Intraoffice Reference Number	F1	Field of Technology Indication
B60Q 1/14		G8715-3K		
F21M 3/05		B8409-3K		
3/18		8409-3K		
H04N 7/18		K		

Request for Examination: not made
Number of claims: 1 OL (9 pages in total)

(21) Application Number: 5-206070
(22) Application Date: August 20, 1993

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(54) [Title of the Invention] LIGHT DISTRIBUTION CONTROL DEVICE FOR HEADLAMPS

(57) [Abstract]

[Object] To illuminate the optimum position to be viewed by the driver, without dazzling the drivers of other vehicles.

[Structure] Data on the presence or absence of other vehicles, distance between the vehicles, and directional angle ϕ that were found in the image processing unit are read (202). When the other vehicle is present, the control angle θ referenced to the headlamps is found from the distance between the vehicles an directional angle ϕ, and the movement

quantity of the actuators which is an actual control quantity for deflecting the optical axis of the headlamp is calculated (204, 206). The optical axis of the headlamps is deflected correspondingly to the movement quantity thus found (208). When the other vehicle is not present, the control quantity corresponding to the road shape is found (204, 210), and the optical axis of the headlamp is deflected (208). As a result, it is possible to obtain light distribution that can be prevented from dazzling the driver of the other vehicle.

[Patent Claims]

[Claims]

[Claim 1] A light distribution control device for headlamps comprising:

image detection means disposed in a position different from that of headlamps that can be changed with respect to at least one of illumination direction and illumination range for detecting images ahead of an own vehicle;

calculation means for finding the detection direction of another vehicle with reference to said image detection means based on the detected image and also finding the distance between the other vehicle and the own vehicle; and

control means for finding the control direction with reference to said headlamps and controlling at least one of the illumination direction and illumination range of said headlamps based on said control direction for preventing the light from falling on the rearview mirror of the vehicle ahead when said other vehicle is a vehicle ahead and preventing the light from illuminating the eye point of the driver of an oncoming vehicle when said other vehicle is an oncoming vehicle, based on the distance from said headlamps to said image detection means, said detection direction, and distance between the vehicles.

[Detailed Description of the Invention]

[0001]

[Field of the Invention] The present invention relates to a light distribution control unit for headlamps, and more particularly to a light distribution control unit for headlamps that controls light distribution of headlamps providing illumination ahead of a vehicle.

[0002]

[Prior Art] Vehicles are equipped with headlamps to improve forward visibility for a driver, e.g., at night. The headlamps are fixed almost at the front end of the vehicle and illuminate a comparatively wide preset range. However, the headlamps cannot illuminate brightly a zone that has to be viewed by the driver when the vehicle turns. For this reason, a headlamp unit for a vehicle in which the illumination optical axis or illumination range of the headlamps are changed correspondingly to the steering angle and a headlamp illumination unit for a vehicle in which an illumination range is changed by opening and closing a shutter provided on the emission side of the vehicle have been

suggested (Japanese Examined Patent Application No. 55-22299, Japanese Utility Model Application Laid-open No. 2-27938, and Japanese Examined Patent Application No. 1-293247).

[0003] However, another vehicle such as a vehicle ahead is usually present in front of the own vehicle. If the light distribution is controlled only from the direction of the own vehicle, e.g., the steering angle, when the other vehicle is present ahead of the own vehicle, the driver of the other vehicle is dazzled. To resolve this problem a headlamp device for a vehicle was suggested (Japanese Patent Application Laid-open 62-131837) in which the space ahead of the own vehicle is picked up with a camera, tail lamps of the other vehicle are image processed based on the picked-up image and extracted, the distance between the vehicles is found from the spacing of the tail lamps that were thus extracted, and the headlamps are switched from a high beam mode to a low beam mode.

[0004]

[Problems Addressed by the Invention] However, the road where the vehicle travels is not necessarily a continuous flat road with a constant surface shape, and there are roads with slopes, e.g., mountain roads. Therefore, the position of the other vehicle on the picked-up image changes. For example, vehicles traveling ahead of the own vehicle can be positioned in the same site on the image picked up with the camera due to height difference of the road. As a result, the position of the other image is sometimes erroneously specified from the image obtained for the zone ahead of the own vehicle and the control provides the light distribution that dazzles the driver of the other vehicle.

[0005] With the foregoing in view, it is an object of the other vehicle to provide a light distribution control unit for headlamps that can illuminate optimum position to be viewed by the driver, without dazzling the driver of the other vehicle.

[0006]

[Means to Resolve the Problems] In order to attain the above-described object, the present invention provides a light distribution control device for headlamps, comprising image detection means disposed in a position different from that of the headlamps that can be changed with respect to at least one of illumination direction and illumination range for detecting images ahead of an own vehicle; calculation means for finding the detection direction of another vehicle with reference to the image detection means based on the detected image and also finding the distance between the other vehicle and the own vehicle; and control means for finding the control direction with reference to the headlamps and controlling at least one of the illumination direction and illumination range of the headlamps based on the control direction for preventing the light from falling on the rearview mirror of the vehicle ahead when the other vehicle is a vehicle ahead and preventing the light from illuminating the eye point of the driver of an oncoming vehicle when the other vehicle is an oncoming vehicle based on the distance from the headlamps to the image detection means, the detection direction, and distance

between the vehicles.

[0007]

[Operation] The light distribution control unit for headlamps in accordance with the present invention comprises image detection means disposed in a position different from that of the headlamps that can be changed with respect to at least one of illumination direction and illumination range. The image detection means detects the images ahead of an own vehicle. An image pick-up device such as a TV camera and a dark-view camera can be used as the image detection means. Furthermore, the illumination direction of the headlamps can be determined by the optical axis of the headlamps, and the illumination range can be determined by a scattering angle of the light emitted from the headlamps, shape of the member shading the light, and position of this member. In the calculation means, the detection direction of another vehicle is found with reference to the image detection means based on the detected image and also the distance between the other vehicle and the own vehicle is found. The other vehicle can be a vehicle ahead or an oncoming vehicle. When a vehicle ahead or an oncoming vehicle travels in front of the own vehicle, the positions of other vehicles in the detected image can be identical due to the road slope ahead of the own vehicle. As a result, when the positions of the image detection means and headlamps are different, if the direction of controlling the headlamps is found from the detected images, the direction different from the desired direction is sometimes obtained. The desired direction can be found by specifying the position of the other vehicle, and the position of the other vehicle can be found from the distance between the headlamps and the image detection means, detection direction, and distance between the vehicles. Accordingly, in the control means, the control direction based on the headlamps is found based on the direction between the headlamps and the image detection means, detection direction, and distance between the vehicles so that the rearview mirror of the vehicle ahead is not illuminated with the light and so that the light is prevented from illuminating the eye point of the driver of the oncoming vehicle, and at least one of the illumination direction and illumination range of the headlamps is controlled based on the control direction that was thus found. Thus, the control is so conducted that the illumination direction and illumination range of the headlamps do not contain the positions or directions causing glare to the other vehicle. Therefore, even if the other vehicle is present on a road having a slope, the road is illuminated with light based on the illumination direction or illumination range optimum for this slope.

[0008]

[Embodiments] An embodiment of the present invention will be described below in greater detail with reference to the appended drawings. In the present embodiment, the invention is applied to the case where images in front of a vehicle 10 are picked up with a camera and light distribution of headlamps is controlled based on the gradation images.

[0009] As shown in FIG. 1, an engine hood 12 is disposed in the upper surface section of a front body of the vehicle 10, and a pair of left and right (both end sections in the lateral

direction of the vehicle) headlamps 18, 20 are disposed above a front bumper 16 fixed to both end sections in the lateral direction of the vehicle in the front section of the front body 10A. A room mirror 15 is provided inside the vehicle 10 in the upper section of the windshield glass 14. A camera 22 for picking up images in front of the vehicle at night is disposed in the vicinity of the view in position (the so-called eye point) of the driver located in the vicinity of the room mirror 15. The camera 22 is connected to an image processing unit 48 (see FIG. 5). A camera for dark viewing based on an image intensifier tube for converting the intensity of a dark visible image obtained by receiving X rays or particle rays and converting it into a bright visible image may be used as the camera 22. Furthermore, a speedometer (not shown in the figure) is disposed inside the vehicle 10. A vehicle speed sensor 66 (see FIG. 5) for detecting the speed V of the vehicle 10 is attached to a cable (not shown in the figure) of the speedometer (not shown in the figure).

[0010] As shown in FIG. 2, the headlamp 18 is a projection-type headlamp and has a lamp housing 34. A convex lens 30 is fixed in one opening of the lamp house 34, and a valve 32 is fixed via a socket 36 in the other opening so that the light emitting point is positioned on an optical axis (central axis of the convex lens 30) of the convex lens 30.

[0011] The valve side inside the lamp housing 34 serves as a reflector with an elliptical reflecting surface, and the reflected valve of the bulb 38 obtained with the reflector 38 is converged between the convex lens 30 and bulb 32. A shade 40 is fixed so that the upper end thereof (see FIG. 3) is positioned in the vicinity of the convergence point. The shape of the shade 40 is determined in advance so as to prevent the driver of the oncoming vehicle from being dazzled and to improve visibility of road marks, etc. The light of the bulb 32 that was reflected and converged by the reflector 38 is divided by the shade 40 into a transmitted light and a shielded light, and the transmitted light is emitted from the convex lens 30.

[0012] Furthermore, a bearing 42 is fixed to the upper front zone 34A of the bulb housing 34. This bearing is supported on a support column 44 fixed horizontally to a frame (not shown in the figure) of the vehicle 10. Furthermore, a cylindrical distal end of a movable element 46A of an actuator 46 is mounted on the lower rear zone 34B. The actuator 46 is fixed to the frame (not shown in the figure) of the vehicle 10 and is composed of a motor 46D and a worm gear using the movable element 46A as a worm. Thus, the rear end of the movable element 46A is machined so as to function as a worm and is engaged with the worm wheel 46B. The movable element 46A can be moved linearly by a sliding mechanism (not shown in the figure), the rotation shaft of the worm wheel 46B is fixed to the shaft 46C of the motor 46D, and the rotation of the motor 46D is converted into a linear drive of the movable element 46A. Therefore, the movable element 46A is extended or contracted in the vertical direction (direction of arrow A in FIG. 2), following the rotation of motor 46D corresponding to a signal from the control unit 50. If the movable element 46A is contracted, the headlamp 18 rotates to the left and the optical axis L becomes an optical axis LU. If the movable element 46A extends the headlamp 18 rotated to the right and the optical axis L becomes an optical axis LD. Thus, the headlamp 18 rotates about the support column 44 correspondingly to the extension or

contraction of the movable element 46A, and the optical axis L is deflected in the vertical direction (UP or DN direction in FIG. 1).

[0013] The headlamp 20 comprises a shade 41 and an actuator 47 (FIG. 5). Because the configuration of the headlamp 20 is identical to that of the headlamp 18, detailed explanation thereof is omitted.

[0014] A cut line, which is a boundary between dark and bright and is formed by the shade, is positioned on the road and is displaced parallel to itself, as shown in FIG. 4, from a position corresponding to the lowermost level of the upper section of the shade (cut line position shown in FIG. 4) to the position corresponding to the uppermost level (position of the virtual line in FIG. 4), following the headlamp rotation. The shade may be also controlled so as to move independently to the left and to the right from the center of the figure.

[0015] As shown in FIG. 5, the control unit 50 comprises a read only memory (ROM) 52, a random access memory (RAM) 54, a central processing unit (CPU) 56, an input port 58, an output port 60, and a bus 62 such as a data bus or control bus that connects the aforementioned components. The below-described control program is stored in the ROM 52.

[0016] A vehicle speed sensor 66 and image processing unit 48 are connected to the input port 58. The output port 60 is connected to the actuators 46, 47 via the driver 64 and also to the image processing unit 48.

[0017] The road shape includes a progression road shape, for example, the road shape corresponding to one lane formed by a center line (white line) or curbstones.

[0018] Recognition processing of another vehicle in the image processing of the present embodiment and computation of the distance between the vehicles will be described below. For the pixels on the image formed by the image signals, the position is specified by coordinates (X_n, Y_n) in a coordination system determined by orthogonal X axis and Y axis set on the image.

[0019] As shown in FIG. 6(1), a vehicle 11 ahead is positioned between white lines 124 located on both sides of a lane of a road 122 where the vehicle 10 travels. The image 120 is processed in the image processing unit 48.

[0020] First, as described below, a white line candidate point extraction processing and linear approximation processing are successively conducted, the traveling lane of the vehicle 10 is detected, and then a vehicle recognition region WP is set.

[0021] In the white line candidate point extraction processing, the candidate points that are assumed to be a white line of the lane are extracted. First, a wind region W_S having the prescribed width γ that is assumed to contain the white line is set (see FIG. (3)). The

point (maximum point of differentiation value of brightness in the vertical direction) with a large change of brightness in the wind region W_S is extracted as a white line candidate point (edge point). The continuation of this edge point is shown by a dot line 132 in FIG. 6(3). Furthermore, because the probability of the vehicle 11 ahead being present in the region above and below the image 120 is low, the range between the low limit line 128 and upper limit line 130 that were set in advance is used as the processing object region.

[0022] In the subsequent linear approximation processing, the edge points extracted in the white line candidate point extraction processing are linearly approximated by using a Hough transformation, and straight lines 134, 136 along the lines that are supposed to be white lines are found. The region bounded by the found straight lines 136, 138 and the lower limit line 130 is set as a vehicle recognition region W_P (see FIG. 6(4)). Furthermore, when the road 122 is a curved road, the vehicle recognition region W_P has a difference in inclination of the found straight lines 136, 138 (see FIG. 6(2)).

[0023] Once the vehicle recognition region W_P has been set, the below-described detection processing is conducted, the presence of the vehicle 11 ahead is evaluated in the vehicle recognition region W_P and, when the vehicle 11 ahead is present, the distance ΔV between the vehicles is calculated.

[0024] First, edge points are detected by the processing identical to the above-described white line candidate point detection processing inside the vehicle recognition region W_P. Then, the edge points that were thus detected are integrated in the lateral direction, and a peak point E_P in the position where the integrated value exceeds the prescribed value is detected (see FIG. 6(5)). When there are a plurality of peak points E_P, the peak point E_P positioned in the lower section on the image (point at a close distance) is selected. The wind regions W_R, W_L comprising the respective both ends of the pixel points in the horizontal direction corresponding to the peak point E_P are set (see FIG. 6(6)). The vehicle 11 ahead is determined to be present when the continuation points (vertical lines 138R, 138L) in the vertical direction were detected in the wind regions W_R, W_L with good stability.

[0025] Because the spacing between the detected vertical lines 138R, 138L in the lateral direction corresponds to the vehicle width, the distance ΔV between the vehicle 11 ahead and the own vehicle 10 is calculated from the position of the horizontal edge of the vehicle 11 ahead and the vehicle width that was thus found. The spacing between the vertical lines 138R, 138L in the lateral direction can be calculated from the difference between the representative X coordinates (for example, average coordinate value or coordinate value with a high frequency of occurrence) of each of the vertical lines 138R, 138L.

[0026] The recognition processing of the oncoming vehicle 11A from the image 120 will be explained below. First, after the above-described recognition processing of the vehicle ahead, a correction value α is set to conduct a correction so as to include the found

approximated line 132 (oncoming vehicle side). This correction is required because the probability of the oncoming vehicle being located close to the approximated line 132 on the oncoming vehicle side is high. The right side of the straight line 133 (when the vehicle travels on the left side) found by finding the straight line 133 corresponding to the correction value α that was thus set is set as the oncoming vehicle recognition region W_{P0} (see FIG. 7). Inside the oncoming vehicle recognition region W_{P0}, the oncoming vehicle 11A is recognition processed similarly to the above-described recognition processing of the vehicle ahead and the distance ΔV between the vehicles is found.

[0027] Furthermore, the road was specified hereinabove by detecting the white line 124, but detection may be also conducted by the curbstone formed on the edge of the road 122, rather by using only the white line 124. In this case, the white line and curbstone can be detected by changing the detection level of the graded image.

[0028] The processing for finding the direction of the other vehicle based on the road slope with the image processing unit 48 from the picked-up image will be described below. FIG. 8 shows an image 120 serving as a standard almost matching the image viewed by the driver when a flat road 122 where the vehicle 10 travels is picked up with the camera 22. In this road 122, the center line 123 is a boundary between the lanes, and the white lines 124 are the boundaries between the road 122 and the space outside the road.

[0029] A reference point $D(X_D, Y_D)$ in the position corresponding to a view line (direction parallel to a flat road) obtained when the driver looks forward parallel to the traveling direction of the vehicle 10 is set in advance in the image 120. The reference point $D(X_D, Y_D)$ serves as a reference point for the image 120 picked up with the camera 22. The line passing through the reference point D and the line perpendicular to the passing line are taken as a horizontal line Hor and vertical line Ver. The horizontal line Hor matches the horizon line of the image 120 picked up when the vehicle 10 travels on a flat road.

[0030] As shown in FIG. 9, an image 121 picked up with the camera 22 when the road 122 ahead of the vehicle 10 traveling on a flat road has a downward slope with an inclination angle θ becomes a compressed image directed in the direction of the slope, and the horizon line of the image 121 moved downward from the position of the horizon line obtained when a flat road 122 is picked up. Therefore, the deviation ΔH between the horizontal line Hm passing through a pixel in the uppermost location of the trajectory of pixels on the image of while line 124 and center line 123 of the image 121 from the horizontal line Hor passing through the reference point corresponds to the aforementioned inclination. Therefore, if the difference ΔH is found after the position of the horizontal line Hm, which corresponds to the horizon line of the image that was picked up, has thus been found and the optical axis L is moved up or down according to the value of the deviation ΔH, then the region providing sufficient visibility for the driver can be illuminated with the headlamps.

[0031] The direction of other vehicle (angle of direction from the horizontal line) with reference to the camera can be found by using such an inclination derivation method. Thus, because the position in the vertical direction on the detected image of the tail lamp corresponds to the direction of other vehicle, the direction of other vehicle can be found if the deviation ΔH is found by using the position of the above-described horizontal line Hm instead of the position of the tail lamp (in the case of the vehicle ahead; headlamps in the case of an oncoming vehicle).

[0032] Here, depending on the inclination of the road ahead of the vehicle, even if the distance between the vehicles is different, the position of the other vehicle on the image can be the same or even if the distance between the vehicles is the same, the position of the other vehicle on the image can be different. As shown in FIG. 10, the position on the image is sometimes the same even when the distance ΔV from the own vehicle 10 to the vehicle 11 ahead is different. In this case, the angle found as a control angle for light distribution control from the image is the angle ϕ. On the other hand, because the distance from the headlamp to the road is different from that of the camera to the road, the control angle θ for deflecting the optical axis of the headlamp becomes different. Thus, for the vehicle 11a ahead that is close to the own vehicle 10, the control angle becomes angle θa, and for the vehicle 11b ahead that is far from the own vehicle 10, the control angle becomes angle θb.

[0033] Accordingly, in the present embodiment, as shown in FIG. 11, if the headlamp position of the own vehicle 10 is denoted by point Q_1, the installation position of the camera is denoted by point Q_2, and the preset position (boundary position, that is, cut line position, of the bright-dark sections of distributed light that does not dazzle the driver of the vehicle 11 ahead) close to the tail lamps of the vehicle 11 ahead is denoted by point QW_3, the control angle θ using the headlamps as a reference can be found from Formula (1) below.

[0034]

[Formula 1]

$$\theta = \tan^{-1}\{[h1 - h2 + (\Delta V + d) \tan \cdot \phi]/\Delta V\} \ldots (1)$$

[0035] Here, h1 is a the height from the road to the point Q_1; h2 is the height from the road to the point Q_2; d is the distance between the point Q_1 and point Q_2 in the horizontal direction; and ϕ is a directional angle of the other vehicle with reference to the camera.

Therefore, if the distance between the vehicles and the directional angle ϕ dependent on the camera are found by using the picked-up image, the control angle θ based on the headlamps is found from the distance between the vehicles and directional angle ϕ that were thus found, and the optical axis L is moved up or down correspondingly to the value of the control angle θ, then the distributed light causing no glare to the other

vehicle can be illuminated by the headlamps in the range providing sufficient visibility for the driver.

[0036] The operation of the present embodiment will be described below. First, if the driver turns on a light switch (not shown in the figure) of the vehicle and switches on the headlamps 18, 20, the main routing of light distribution control shown in FIG. 12 is executed for each prescribed interval and the processing flow advances to step 202. In step 202, an image read signal, which is a command signal to start image processing, is outputted to the image processing unit 48 and the data relating to the presence of other vehicle that were found are read in the image processing unit 48. If the image read signal is inputted into the image processing unit 48, the picked-up image is processed in the below-described manner, the presence or absence of the other vehicle is established and the distance between the vehicles and directional angle ϕ are found.

[0037] The next step 204 determines whether or not the other vehicle was recognized in the image processing unit 48, and when the other vehicle is present on the image (positive decision), the routine advances to step 206. In step 206, the control angle θ related to the headlamps is found based on Formula (1) presented hereinabove from the distance between the vehicles and directional angle ϕ found in the image processing unit 48, and the movement quantity of actuators 46, 47 corresponding to the angle formed by the optical axis l, which is the actual control quantity, is calculated. In this case, the maximum movement quantity of the actuators 46, 47, which is the control angle θ, is found, and if the movement quantity is less than the maximum movement quantity, it causes no glare to the other vehicle, regardless of the actual value of the movement quantity. For example, in the vehicle ahead, it may be below the position of the door mirror or fender mirror that is determined in advance from the position of the tail lamp, and in the oncoming vehicle it may be below the position of the eye point of the occupant that was determined in advance from the headlamp position.

[0038] In the next step 208, the actuators 46, 47 are moved correspondingly to the movement quantity that was thus found, the optical axes of the headlamps 18, 20 are deflected, and the present routine is completed.

[0039] On the other hand, when the other vehicle is determined in step 204 to be absent, the routine proceeds to step 210. When the other vehicle is not present, then there is a road ahead of the vehicle. Therefore, an assumption is made that the vehicle travels on a flat road and the control value is determined by using as the control angle θ the angle determined in advance so as to illuminate the region providing sufficient visibility for the driver. Furthermore, when a slope is present on the road, the control value is determined by using as the control angle θ the directional angle ϕ corresponding to the slope of the road with respect to the flat road as a reference.

[0040] Image processing in the image processing unit 48 of the present embodiment will be described below with reference to FIG. 13. If an image read signal is inputted from the

control unit 50 to the image processing unit 48, the image 120 of the image ahead of the vehicle 10 that was picked up with the camera 22 (see FIG. 5(1)) is read (step 302). The recognition processing of the vehicle ahead and oncoming vehicle that was explained hereinabove is then conducted by using the image 120 that was read (step 304). In the next step 306, a decision is made as to whether or not the other vehicle is present on the image. When the other vehicle is present on the image (positive decision), the routine proceeds to step 308. In step 308, the distance ΔV between the vehicles is found by the image processing finding the spacing in the horizontal direction of the edge points that are extracted in the above-described manner. On the other hand, when the other vehicle is not present (negative decision is step 306), it is not necessary to find the distance ΔV between the vehicles. Therefore, the routine advances to step 310.

[0041] In step 310, the directional angle ϕ determined by the slope of the road is found by finding the displacement of the horizontal line that moves on the image as described hereinabove. In step 310, when the other vehicle is present, the directional angle ϕ is found by taking a preset position preventing glare to the other vehicle (for example, the position determined in advance from the position of tail lamps of the vehicle ahead, or the position determined in advance from the position of the headlamps of the oncoming vehicle) as the horizontal line position.

[0042] In the next step 312, data representing the presence or absence of the other vehicle, distance ΔV between the vehicles, and directional angle ϕ, that were found in the above-described manner, are outputted and image processing is completed.

[0043] Thus, in the present embodiment, the control angle θ based on the position of the headlamps that will be actually controlled is found from the direction angle ϕ determined by the camera and the distance between the vehicles found by using the picked-up image, and light distribution control is conducted correspondingly to the value of this control angle theta. Therefore, the light providing sufficient visibility for the driver and preventing glare to the other vehicle can be emitted by the headlamps.

[0044] Furthermore, in the present embodiment, light distribution control was carried out, but the present invention is not limited thereto and can be also applied to devices for controlling light distribution by moving shading means such as a shape installed at the emission side of the light source.

[0045] Furthermore, in the present embodiment, the case was explained in which the distance between the vehicles was found from the image picked-up by the camera, but a device for measuring the distance between the vehicles may be provided separately on the vehicle to measure the distance between the other vehicle and own vehicle.

[0046]

[Effect of the Invention] As described hereinabove, the following effect is obtained with

the present invention. Thus, because at least one of the illumination direction and illumination range of the headlamps is changed based on the distance between the headlamps and the image detection means, detection direction, and distance between the vehicles, the optimum position can be illuminated with the headlamps even when the control quantity such as the position of the shading means or angle of optical axis at the time of light distribution varied, e.g., due to the slope of the road.

[Brief Description of the Drawings]

FIG. 1 is a perspective view, as viewed at an angle from ahead of the vehicle, that illustrates the front section of the vehicle of the present embodiment.
FIG. 2 is a schematic structural diagram illustrating the headlamp to which the present invention can be applied.
FIG. 3 is a diagram showing the shade structure (cut view in FIG. 2).
FIG. 4 shows an image for explaining the cut line shifting due to extension and contraction of actuators.
FIG. 5 is a block-diagram illustrating the schematic configuration of the control unit.
FIG. 6 shows an image for illustrating the process of recognizing a vehicle ahead based on the image outputted by the camera.
FIG. 7 is an image illustrating the oncoming vehicle recognition range.
FIG. 8 illustrates image signals outputted by the camera.
FIG. 9 is a picked-up image of the road having a slope.
FIG. 10 is an image illustrating the state of own vehicle and vehicle ahead that travel on the road with a slope.
FIG. 11 shows an image explaining the control angle in the road having a slope.
FIG. 12 is a flowchart illustrating the main routine of light distribution control of the present embodiment.
FIG. 13 is a flowchart illustrating the processing routine of the image processing unit of the present embodiment.

[Keys]

18 headlamps
22 camera
48 image processing unit

FIG. 1

18 HEADLAMP
22 CAMERA

FIG. 4

NON-ILLUMINATED REGION
ILLUMINATED REGION
CENTER

FIG. 5

48 IMAGE PROCESSING UNIT
58 INPUT PORT
60 OUTPUT PORT
64 DRIVER

FIG. 12

START
202 IMAGE PROCESSING COMMAND DATA ARE READ (ϕ, ΔH)
204 IS OTHER VEHICLE PRESENT?
206 CONTROL QUANTITY IS CALCULATED
210 CONTROL QUANTITY IS CALCULATED
208 MOVEMENT IS CONTROLLED
END

FIG. 13

START
302 IMAGE IS READ FROM CAMERA
304 OTHER VEHICLE RECOGNITION PROCESSING
306 IS OTHER VEHICLE PRESENT?
308 DISTANCE BETWEEN VEHICLES IS CALCULATED
310 CONTROL ANGLE ϕ IS CALCULATED
312 OUTPUT
END

VERIFICATION OF A TRANSLATION

I, the below named translator, hereby declare that:

My name and post office address are as stated below:
Boris Zhupanov, 5097 Glenaire Drive, Dublin, Ohio 43017

That I am knowledgeable in the English language and in the language in which the below identified international document was written, and that I believe the English translation of the attached document

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is a true and complete translation of the above identified document.

I hereby declare that all statements made herein are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the document.

October 16, 2005
Date

Boris Zhupanov

Full name of translator

B. Zhupanov

Signature of translator